EXHIBIT 49

cisco Systems ASM/AGS
User Manual
and
Configuration Guide

Version 5.2

July 20, 1986

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Table of Contents

1. Introduction

This document describes the use and configuration of the software for the cisco Systems ASM Communications server and the AGS Gateway server[1]. This document corresponds to software version 5.2 and is subject to change without notice

The software base is the same for the ASM and AGS. The term "ASM" will be used where the discussion applies to both the ASM and AGS hardware configurations. "AGS" will be used to emphasize that the Gateway Server hardware configuration is being discussed.

Complete specifications of the Internet Protocols employed in the cisco Systems software may be found in the *DDN Protocol Handbook*, available from the DDN Network Information Center, SRI International, 333 Ravenswood Avenue, Menlo Park, CA 94025.

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[1]ASM and AGS are trademarks of cisco Systems, Inc., all rights reserved

2. ASM Communications Server

The basic ASM hardware is a MC68000 processor with 1MB of memory, a special function card containing, among other things, non-volatile memory for boot time auto-configuration, and two boards supporting 32 RS232 serial lines. A Multibus-I backplane is used as an I/O bus. The basic configuration may be augumented with more serial lines in increments of 16, up to a total of 80 lines. Parallel printer interfaces supporting up to a total of four printers may also be added.

2.1. Basic ASM Use

To get the attention of the ASM's command processor, you must press the RETURN key. A message may be printed out, followed by the ASM's host name. The ASM is then ready to accept commands. See figure 2-1. Words in **boldface** are typed by the user; normal type is printed by the ASM; and *italics* are comments. "Sierra" is the name of a timesharing computer.

```
<CR>                                This is the RETURN key.
UNIX 4.3 BSD installation on Mojave has been completed.
Report any problems to admin.
ASM-AELb> sierra<CR>
 Trying SIERRA (36.10.0.13)... Open

<Sierra login session>
        :
        :
<Logout from Sierra>
[Remote Disconnect of ASM-AELb from Sierra]
ASM-AELb> exit<CR>


Press RETURN to get started!
```

Figure 2-1:   Example ASM Session

After you have a prompt, the most common action is to type in the name of the host to which you wish to connect and press the RETURN key. The ASM will either connect you to that host or print out a message explaining why it could not. When you are done, you need only log out from the host. Your ASM terminal will become inactive in about ten minutes or when you give the **exit** command.

You may have more than one connection at a time and switch back and forth between them. To do this, get back to the EXEC by typing the *escape sequence*, usually CTRL/^, followed by 'x'. See the **set escape** command for further details. At that point just make a new connection by typing the host name. To get back to an existing connection use the **resume** command. The **where** command will show your open connections.

The ASM's command parser allows abbreviation of unique commands. You can also use the question mark to get help, even in the middle of a command. It doesn't matter which case you use in typing the ASM commands.

2.2. Description of User Commands

This section describes the basic ASM commands that are available to all users. By supplying a password to the **enable** command, further commands may be added for privileged configuration and monitoring functions. The privileged commands are described in section 4.

In the following descriptions, keywords are in **boldface**, values are in *italics*, and anything in [brackets] is optional. All keywords may be abbreviated.

help

?   Print out a short summary of the commands and their functions.

connect *host [port] [debug]*
host [port] [debug]

         Takes a host name or host address as an argument and connects the user to the telnet server on that host. A optional decimal TCP port number may be specified. The optional keyword "debug" enables debugging output of Telnet option negotiations. The resulting connection is assigned a *logical name* that may be used by other commands to refer to that connection . The logical name is the same as the host name unless the name is already in use or is changed with the **name-connection** command. You may leave off the **connect** command and just type the host name or address to the ASM prompt. Host addresses are specified in IP format *dd.dd.dd.dd.*

disconnect

disconnect *connection*

         Aborts a connection. You may specify a connection number or name as a parameter; the default is your current connection. Typing a question mark will list your open connections. You should not normally use this command; you should log out of the host instead.

quit

exit   Cause the ASM EXEC to exit, leaving the terminal in an inactive state. If you have open connections, the ASM will ask you for confirmation before it tries to close them.

where   Lists information about all of your open connections. The host name, address, number of characters waiting to be sent to the terminal, idle time in hours and minutes, and the connection name are displayed. An asterisk indicates the current connection.

resume *connection*
resume
number
<CR>   Resume a specific connection, named by the connection name or number. The
             default is the current connection. Typing just the connection number will resume
             that connection. Typing just RETURN to the ASM prompt will resume the current
             open connection.

name-connection
             Prompts for a connection number and a "logical name" to assign to that connection.
             The logical name can then be used to reference that connection, for example, with
             the **resume** command. This is useful when you have two or more connections to the
             same computer.

set download
unset download
             For use when running Kermit, Modem, and similar microcomputer to mainframe file
             transfer programs. It disables the local hold and escape characters, and tries to
             maximize the size of packets sent over the network. When in download mode,
             BREAK is the escape character.

set escape *character*
unset escape
             Set the escape character, the character that returns you to the ASM's EXEC when you
             are connected to a computer. Normally this character is CTRL/^ and it must be
             followed by the letter "x". If you do not specify a character when giving the **set
             escape** command, your escape character will be the NUL character. The **unset
             escape** command will set your escape character to BREAK[2]. Note that typing just the
             BREAK character will return you to the command level; you need not type the "x".
             The escape character may also be used to abort name to address lookups and
             connection attempts. Other special characters, such as the local hold character, may
             be quoted with the escape character.

set hold *character*
unset hold Sets the hold character, used to pause the output to your terminal. To unpause your
             terminal, type any character. Note that the hold character is not sent back to the host
             unless you precede it with the escape character. Use the **unset hold** command to
             clear the hold character.

set notify

---

[2] It is not possible to use BREAK as an escape character on the console terminal. BREAK on the console is normally
used to force a running system into its ROM monitor program. See Appendix B for further information.

unset notify

> If set, the ASM will tell you when there is new output on connections other than your current one.

show hardware

> Displays the system's hardware configuration, software version, configuration information, and protocol addresses.

show hosts Display information relating to name/address translation, including the default domain, the domain server addresses, lookup methods being used, and the contents of the host name/address cache. Cache entries are flagged with whether they are temporary (obtained from a name server) or permanent (obtained via the **configure** command), whether the entry is considered suspect, and the time in hours since the entry was last used.

show terminal

> Displays terminal configuration information.

show users
show users all
systat
systat all   Display information about the ASM's active lines. The line number, connection names, and terminal location are displayed. The optional **all** keyword requests information on all lines, both active and inactive.

terminal databits 5|6|7|8
terminal flowcontrol in|out none|hardware|software
terminal length *lines*
terminal parity none|even|odd
terminal speed *speed*
terminal start-character *decimal-number*
terminal stop-character *decimal-number*
terminal stopbits 1|2
terminal terminal-type *text*

> The **terminal** commands allow users to change the hardware parameters their current line. The configuration mechanism must be used to change the settings of other lines. Note that the console line (line zero) is special in that none of its hardware parameters aside from baud rate (see Appendix B) may be changed.

2.3. Connecting to an ASM -- Rotary Groups

In addition to initiating TCP connections, the ASM is capable of receiving incoming TCP connections. This makes it possible to attach serial and parallel printers and drive them remotely from other systems. By attaching the serial ports of a computer system to the ASM's serial

ports, it possible for the ASM to act as a "network front end" for a host that is incapable of using TCP/IP protocols.

Individual lines may be specified as receiving incoming connections. Rotaries of lines may also be set up. An incoming connection to a rotary group is assigned the next free line. The "rotary *group*" command is used to put a line in a rotary group. A line may be in only one rotary group.

The access control mechanism may be used to restrict incoming connections on a per line and per host or network basis. See section 5.4 for details.

The **host** configuration command can be used to bind a host address and port to a name. For example, suppose there was a microcomputer attached to line 1 of the ASM called ASM-AELB, host 36.40.0.85. If you gave the configuration command "host JOES-PC 2001 36.40.0.85", you could type "JOES-PC" instead of "ASM-AELB 2001" to connect to the non-TCP speaking microcomputer.

Below is a summary of the ASM's special TCP ports. The port numbers are given in decimal and are grouped in 1000's (decimal). The three least-significant digits may represent a line number or rotary group number.

23_{10} (Telnet)

> Connect to a virtual Telnet terminal providing an ASM EXEC. Such connections are used primarily for remotely monitoring and configuring ASMs.

$2000_{10}+line$

> Connect to the specified line. This may be any type of line such as a TTY or line printer, but not the console. No flow control (XON/XOFF) is done and the connection is transparent, that is, the escape character has no effect. There must not be an active process on the line. Note that line numbers are always printed and specified to the ASM in octal, so you will usually have to convert *line* to decimal. The Telnet protocol is used to negotiate options.

$3000_{10}+group$

> Connect to a free line in the specified rotary group. The **rotary** configuration command determines which lines are in rotary groups. The line conventions are as specified by the line's configuration. Other than the method of selecting which line to connect to, there is no difference between connecting to a rotary line and connecting to a specific line. The Telnet protocol is used to negotiate options.

$4000_{10}+line$

> Connect to the specified line, as above, except using a raw TCP byte stream, that is, no Telnet protocol negotiation.

$5000_{10}+group$

>   Connect to the next free line in a rotary group, as above, except using a raw TCP byte stream, i.e., no Telnet protocol negotiation.

All connections are always full-duplex streams of 8-bit bytes, even when the Telnet protocol is in use. The BREAK "character" may be sent over Telnet connections. If there is a session timeout set for a line and if there is no activity on a remotely initiated connection for that amount of time, the connection will be closed on the assumption that the remote host has crashed or is otherwise inaccessible.

3. AGS Gateway Server

The basic AGS hardware is a MC68000 processor with 1MB of memory and a special function card containing, among other things, non-volatile memory for boot time auto-configuration. A Multibus-I backplane is used as an I/O bus. To complete the configuration, two or more network interfaces are added.

All AGS configurations support up to five Ethernet interfaces. The A series AGS systems also support the EGP protocol and ARPA/1822 interfaces. The S series systems support RS232 synchronous interfaces at 56 Kbps speeds. The V series systems support V.35 synchronous interfaces.

3.1. Gateway Initialization

During the boot time initialization process, the AGS attempts to determine its interface addresses. If valid non-volatile memory is available, the information is taken from there and the initialization process continues.

Lacking good on-board information, the AGS will attempt to use Reverse ARP (see RFC826) or the Boot Protocol (see RFC951) to determine the addresses. Once one address becomes known, others can be discovered via a configuration file TFTP booted over a known interface.

If all else fails, the AGS will prompt on the console terminal for the address and network mask (for subnetting) of each unknown interface.

Once all interface addresses are known, the AGS will complete its initialization sequence and automatically begin exchanging routing information with other gateways and routing IP datagrams.

Gateway processing may be disabled with the privileged **unset gateway** command or with the **no gateway** configuration command. These commands will also cause a graceful shutdown of any routing processes, such as IGRP or EGP.

3.2. Routing Support

The most important function of the AGS is its ability to route IP datagrams in a general fashion. To accomplish this, the AGS must be able to determine routes, their connectivity, and their relative costs.

Networks are known to the AGS via four means: those that are directly connected, static routing entries, those discovered via IGRP, and those discovered via EGP. The privileged command

show routes will list all known networks and subnets and the means by which they were discovered.

Directly connected networks are those on which the AGS has an actual interface. These networks may be of any class (that is, A, B, or C) or combination of classes. By using the network mask, the presence of subnetting on a directly connected net is determined using the methods outlined in RFC950. Each directly connected major IP network (as contrasted with a subnet of a major IP network) must have a routing protocol specified with a **routing-protocol** configuration command before the AGS will begin operation.

Static network entries are ones entered by the **route** configuration command. It is not currently possible to enter a static subnet route. With the optional **default** keyword, it is possible to specify the gateway of one of these routes as the gateway of last resort. Such a gateway is usually an exterior gateway that handles traffic destined for hosts not on the local network.

The Interior Gateway Routing Protocol (IGRP) is used by the AGS Gateways to exchange subnet routing information as well as information regarding networks directly connected to the system of AGS Gateways. Information on delay, link speed, bandwidth utilization, maximum transmission unit, and unreliability is also exchanged. IGRP updates are broadcast (hardware permitting) periodically and when the network topology changes. Aging of entries is done to detect crashed gateways.

The Exterior Gateway Protocol (EGP) as specified in RFC904 is used to exchange neighbor reachability and routing information between "core" autonomous systems and the local autonomous system. Currently the AGS implementation operates only in "local" mode, that is, it does not pass on routing information gleaned from other autonomous systems. EGP neighbors are specified by the **egp-neighbors** configuration command. Current EGP status is displayed by the **show egp** privileged command. A debugging output of EGP transactions can be obtained by giving the command **set egp-tracing**.

3.3. Multi-Path Routing

If there are multiple, equal cost routes to a network or a subnet, the AGS will use each path in a round robin basis. Up to four parallel routes are maintained. If EGP or IGRP declares a route dead, it will be discarded. If a better route is discovered, the existing route(s) will be discarded in its favor. The IGRP implementation is such that routing loops are avoided. Since the EGP implementation does not advertise local routing information to the core network, there is no danger of EGP inspired routing loops.

Multi-path routing enhances the gateway system's reliability through redundancy. If one gateway fails, there will be minimal disruption to network traffic until the rest of the gateways determine that the network topology has changed. If an AGS gateway is taken down gracefully with a **unset gateway** command, there should be no disruption at all.

Multi-path routing also acts to balance the network load across multiple gateways, reducing the possibility of congestion at the gateways.

3.4. Gateway Services

In addition to routing, the AGS gateways provide several other useful services, including proxy ARP, forwarding UDP broadcasts from selected subnets, and Boot Protocol forwarding.

Proxy ARP is the mechanism that allows hosts without knowledge of subnetting to function properly on a subnetted network. Such a host naively assumes that all hosts are on the same (10MB Ethernet) cable and therefore ARP can be used to determine their hardware addresses. When an AGS gateway receives an ARP for a host that is not on the same cable as the ARP sender and if the AGS knows a route to that host, the AGS will respond with the AGSs' own Ethernet hardware address. In essence the gateway lies to the naive host about its IP address, with the result that all the correct actions occur.

A "stranded subnet" is a subnet without any hosts to provide such useful UDP services such as name to address lookup, address discovery, time, and so forth. Most of these services are invoked by broadcasts on the local subnet. If an AGS knows that an interface (subnet) is stranded, it will forward all UDP broadcasts originating on that subnet to a "helper subnet" elsewhere on the local network. As a safety measure, the stranded and helper subnets must be on the same IP network. An AGS will never forward broadcasts from other than a stranded subnet. Care must be taken not to create broadcast loops.

RFC951, the Boot Protocol, specifies a UDP based method of determining a host's IP address, given its (10MB Ethernet) hardware address. In a heavily subnetted environment, there may not be a server host on the same cable as the host attempting to discover its address(es). RFC951 specifies a mechanism where IP gateways give an assist to isolated hosts by forwarding BOOTP messages to other more helpful subnets. The AGS gateways support this mechanism by forwarding BOOTP messages with a delay field of greater than five. The messages are forwarded only from subnets marked as "stranded".

3.5. Gateway Monitoring

In addition to an optional console terminal, each AGS gateway supports up to five incoming Telnet connections. The entire ASM/AGS command set is available from these Telnet connections. By connecting to an AGS host in this manner, that condition of the AGS may be monitored and any adjustments made. Access to the AGS hosts may be controlled with the access list mechanism described in section 5.4.

4. Privileged Commands

In addition to the basic commands described in section 2.2 there are additional commands for configuring and monitoring the ASM/AGS system. These commands are added to the basic list by supplying a privileged password to the **enable** command. The ASM prompt will become the ASM's name followed by a "#" sign. The **disable** command will remove the privileged commands from the command list.

There is a default password for the **enable** command. To set your own password, you must use the **configure** command and/or a configuration file to set a password on terminal line zero, the console. Note that on the console line it is always possible to use the **enable** command without supplying a password.

Some of the privileged commands are status displays of interest primarily to persons monitoring the ASM's performance. Other commands actually modify the ASM's behavior. The more dangerous of these commands will ask for confirmation before proceeding.

In the following descriptions, keywords are in **boldface**, values are in *italics*, and anything in [brackets] is optional. All keywords may be abbreviated.

banner   Set the login banner that is displayed when an ASM EXEC is created. You will be prompted for the banner, which may be several lines long, terminating with a CTRL/Z. CTRL/C aborts the command. Note that once you start entering a new message, the old message is discarded. See also the **banner** configuration command described in section 5.1.

clear arp-cache

Remove all entries from the ARP cache.

clear host *host*

Remove an entry from the host name/address cache displayed by the **show hosts** command. If the argument is an asterisk, the entire cache is cleared.

clear line *line-number*

Abort any connections, kill associated processes, and reset the data structures associated with the terminal line. This command is useful for clearing lines or connections that have hung for some reason.

configure   Alter the ASM's configuration parameters. You may either give configuration commands directly from the terminal or read a configuration file over the network and execute its commands.

You will be prompted for a number of options, the first of which is "terminal" or "network". If you specify "terminal", you will be prompted for configuration commands. Enter as many command lines as you wish. You may edit using the DELETE and CTRL/W keys, restart with CTRL/U, or abort with CTRL/C. Type CTRL/Z to end input. The configuration commands will then be executed and you will be notified of any errors.

If you specified "network" as the source of the configuration commands, you will be prompted for a source IP address, the type of configuration file (either "host" or "network"), and the name of the configuration file. User confirmation is requested before the ASM uses the TFTP protocol to load the file. Any error diagnostics will be printed on the terminal. To avoid unpleasant surprises, active lines are not touched when configuring over the network.

ping
Sends an ICMP Echo Request datagram to an IP address and waits for an ICMP Echo Reply. Prompts for the Internet address, repeat count (default 5), datagram size (default 576 bytes), and time out interval (default 2 seconds).

reload
Halt the ASM/AGS system. If the system is set to restart on error (see Appendix B for details), it will reboot itself.

send *
send *line-number*
Send a message to the specified ASM terminal line, or, if the argument is an asterisk, send the message to all terminal lines. You will be prompted for the message, which may be several lines long, terminating with a CTRL/Z. CTRL/C aborts the command.

set egp-tracing
unset egp-tracing
(AGS ARPA gateway only) Enable or disable the detailed printout on the system console of all EGP transactions.

set gateway
unset gateway
(AGS only) Turn gateway processing on or off. When the gateway is turned off, it sends out a routing information packet indicating it is no longer routing traffic, remains in operation for a few more seconds, and then stops forwarding packets.

set imp-loopback
unset imp-loopback
(AGS ARPA gateway only) Put all ARPA-1822 interfaces into self loopback for testing purposes.

set line-debugging

unset line-debugging

>   (ASM only) Print serial line debugging information on the console terminal. Useful for debugging modems, autobaud lines, and similar devices. Messages are printed out at important state transitions.

set tracing
unset tracing

>   (AGS only) Turn packet tracing on or off. This slows down the processing of packets considerably, so it should not be used frivolously. The source, eventual destination, and next destination are printed for forwarded packets. Gateway routing activity is also noted.

show access-lists

>   Displays the access control lists. See the discussion in section 5.4 for more details.

show arp   Display the address resolution (ARP) cache and associated statistics.

show buffers

>   Show utilization statistics for the network packet buffer allocator.

show imp-hosts

>   (AGS ARPA gateway only) Show all hosts with which the AGS has exchanged traffic via its 1822 interface(s) during the past five minutes. RFNM counts, up/down status, and the count of datagrams sent are displayed.

show interfaces

>   Display statistics about the ASM's network interface(s).

show line
show line *line-number*

>   With no arguments, this command displays a summary of the state of the ASM lines. By specifying a particular line number, more detailed information may be obtained. The summary information includes:
>
>   * If the line is active, an asterisk is shown.
>   * The line number, in octal.
>   * Line type -- one of CTY (console), TTY (serial terminal line), LPT (parallel line printer), VTY (virtual terminal).
>   * Current transmit and receive baud rates.
>   * Autobaud detect range -- high (H), low (L), or none (-).
>   * Line mode, e.g. Direct, Modem, Printer, Virtual.
>   * Status bits -- see Appendix A.
>   * Capability bits -- see Appendix A.
>   * Rotary group, if any.

- Access class, if any, for incoming (rotary, virtual terminal) connections.
- Access class, if any, for outgoing (terminal) connections.
- The total number of connections made to or from that terminal line since the ASM was booted. This count is useful for determining terminal line utilization.
- The total number of "noise" characters received. A noise character is any non-activating character received when the line is inactive or as a framing error received at any time. The activating character is usually RETURN, but may be changed to be any one, or all characters. Having an excessive number of noisy lines can result in degraded ASM response.

show memory

>Display statistics on the activities of ASM's memory allocator.

show options

>Show the state of options set via the privileged **set** and **unset** commands.

show printers

>(ASM only) If the ASM has parallel printers, show status information regarding those printers.

show processes

>Display information on all active processes.

show routes
show routes *network*

>Display the ASM/AGS system's current understanding of the topology of the local networks and knowledge of exterior gateways and networks. If a network is specified, show the route, if any, to that network.

show stacks

>Monitor the stack utilization of processes and interrupt routines. Primarily for software debugging.

show tcp
show tcp *line-number*

>Display the status of the TCP connections for the specified line, or when no argument is given, the status of all TCP connections.

show traffic

>Show network protocol traffic statistics.

5. Configuration Commands

At boot time an ASM without non-volatile configuration memory will attempt to use TFTP to read in two configuration files. The TFTP read requests are broadcast on all interfaces capable of interpreting broadcasts. The first configuration file is named "network-confg" and contains configuration information applicable to all hosts on the local network. The second configuration file contains configuration commands specific to that ASM. If the ASM's host name was ASM-AELb, for example, its host configuration file name would be "asm-aelb-confg". An ASM unable to determine its host name will try to load "asm-confg"; an AGS system with the same problem will try to load "gateway-confg". There are no restrictions as to which configuration commands may appear in which configuration files.

If the ASM is unable to load one or both of the configuration files, it will retry at ten minute intervals until the TFTP load succeeds, an appropriate configuration file is manually loaded, or a **no lookup config** configuration command is given.

The privileged command **configure** may be used to reload a host or net configuration file while the ASM is in operation. Just before a host configuration file is parsed, the ASM resets all non-active lines to their default settings. This allows the user to remove attributes by merely editing that attribute out of the configuration file and then reconfiguring. Beware that the ASM will not reconfigure any lines that have active connections. This prevents unpleasantness such as the line speed changing in the middle of a session.

Note that all configuration commands may be typed in from a terminal using the interactive option of the **configure** command.

In addition to the commands described below, comments may be put in configuration files. A comment line is begun with the the word **comment** or the symbols "!", "#" or ";" followed by a space. All text until the end of line is ignored. It is always legal to include either **not** or **no** in front of a command keyword. It is not always meaningful or effective to do so, however. Commands for which negation is useful are indicated in the descriptions below. The end of a configuration file is signaled by the **end** keyword. The ASM treats configuration commands in a case-insensitive manner. Sample configuration files are included in section 5.5.

In the following descriptions, keywords are in **boldface**, values are in *italics*, and anything in [brackets] is optional. All keywords may be abbreviated. Commands for which the negation is other than simply preceding the command with **no** are shown in both their positive and negative forms; the differences are usually just omitting trailing arguments.

5.1. Host Configuration Commands

The following commands apply to entire host, whether it be an ASM or AGS. Terminal line and network specific commands are described in their own sections.

access-list *list* **permit|deny** *address mask*

> Adds a permit or deny operation to access list number *list*. *Address* is the IP address to be tested and *mask* is a mask in IP address format where 1's represent bits that are ignored in the test. See section 5.4 for further details.

arp *IP-address ethernet-address*

> Install a permanent entry in the ARP cache. Most reasonable IP implementations include ARP support, making this command unnecessary except in a few cases. The *ethernet-address* is a dotted triple of hexadecimal digits, for example, "0800.0C00.1F5C".

banner *c message c*
no banner

> Set the contents of the login banner or message of the day that is displayed when an ASM EXEC is started. The banner keyword is followed by white space followed by a delimiting character, followed by one or more lines of text, terminated by the second occurrence of the original delimiting character. For example,

```
banner #Building power will be off from 7:00AM until
9:00AM this coming Tuesday.
#
```

> The delimiting character may not occur in the banner message.

configure *address* **net|host** *filename*

> On a large network, it may not be convenient or practical to have a frequently updated configuration file for an ASM reside on a mainframe host on the same subnet or even on a stranded subnet's helper subnet. This command allows you to select a second configuration file to be read from the designated host with the specified name. No further nesting is allowed. The commands from the second file override the commands of the first file.

[no] gateway

> (AGS only) When an AGS host comes up, gateway processing is turned on by default. This command allows you to toggle gateway processing. Before a gateway shuts off gateway processing, it sends a routing update announcing that it is no longer participating in the routing process.

host *name [port] address address ...*

> Preloads the host name and address cache with the indicated information. The decimal port number may be omitted; if it is, the Telnet port is assumed. Up to eight IP addresses may be specified. Note that this command can be used to set up aliases for hosts and even host and port pairs.

hostname *name*

> Specifies the name to be used as the hostname in the prompts and configuration file names. Preserves case.

interface *type unit address subnet-mask* [*mtu*]

> Define the address of an interface installed in this AGS or ASM. *Type* is one of SUN (3MB Ethernet), **3Com** (10MB Ethernet), **Interlan** (10MB Ethernet), **HDLC-56** (56 Kbps serial), or **ARPA-1822**, the type of board installed. *Unit* is an integer from 0 on up, defining which board of that *type* is being described. *Address* is the Internet address of that interface. *Subnet-mask* is the mask of the network and subnet portions of the interface *address*. *Mtu*, if provided, sets the maximum packet size, in bytes, that will be sent through this interface. A list of the interfaces is printed on the console at boot time and is available with the **show interfaces** command.

5.2. Terminal Line Configuration Commands

Most of an ASM's host configuration file consists of terminal line specific configuration groups. Such a group starts with a **line** command. A **line** command may specify a particular terminal line, in which case succeeding commands up to the next **line** command apply to that terminal line. A contiguous range of terminal lines may also be specified by the **line** command. This allows configuration parameters to be set identically for a large set of terminal lines. After the defaults are set, another **line** command can be used to set any special characteristics, such as **location**, for individual terminal lines. Note that ASM line numbers are always octal. See the example in section 5.5.

line *line-number*

> Specify a single line for which subsequent commands apply.

line *first-line last-line*

> Specify a contiguous group of lines for which subsequent commands apply.

No actions will be taken if a line or range of lines has not been selected.

access-class *list* **in | out**
no access-class in | out

> Restrict connections on this line to IP addresses that "match" the specified access list. The keyword **in** applies to incoming (rotary, virtual terminal) connections, while **out** applies to outgoing (terminal line) connections. See section 5.4.

activation-character *value*
no activation-character

> Define the activation character, that is, the character typed on a vacant terminal to get the ASM's attention. *value* is the decimal number representing the selected character. Normally RETURN (decimal 13) is the activation character. The

command **no activation-character** will cause any character to activate an ASM terminal.

[no] autobaud low|high

> Specifies automatic baud rate detection over a low range of speeds (300, 600, 1200, and 2400 baud) or a high range of speeds (2400, 4800, 9600, and 19200 baud). You must type at least two RETURN's to a line that is doing autobaud detection.

busy-message *host c banner c*
no busy-message *host*

> Defines a message to be printed when an attempt to connect to the specified host fails. The command syntax is similar to the **banner** configuration command.

databits 5|6|7|8

> Set the number of data bits per byte. The default is eight data bits per byte.

disconnect-character *value*
no disconnect-character

> Define the session disconnect character. *value* is the decimal number representing the selected character. The BREAK character is represented by zero; NUL cannot be represented. By default no session disconnect character is set. A user may quote the session disconnect character by preceding it with the escape character.

[no] exec   Determines whether or not an ASM EXEC will be created on this terminal line. Serial printers, for instance, should not have EXECs created. By default EXECs are created on all terminal lines.

escape-character *value*
no escape-character

> Define the escape character. *value* is the decimal number representing the selected character. The BREAK character is represented by zero; NUL cannot be represented. The default escape character is CTRL/^.

exec-timeout *interval*
no exec-timeout

> Define the interval (in minutes) that an ASM EXEC will wait for typein before either returning the terminal to an idle state or resuming the current connection. The default interval is ten minutes; an interval of zero implies no timeouts.

flowcontrol none|software|hardware [in|out]

> Define a direction and method of flowcontrol between the terminal or other serial device and the ASM. If a direction is not specified, both will be assumed. By default there is no flowcontrol of any type in either direction. If software flowcontrol is desired, the default start and stop action action characters (CTRL/Q and CTRL/S) may be changed with the **start-character** and **stop-character** configuration commands.

hold-character *value*
no hold-character

> Define the local hold character. *value* is the decimal number representing the selected character. The BREAK character is represented by zero; NUL cannot be represented. By default no local hold character is set. A user may quote the hold character by preceding it with the escape character.

length *screen-length*

> Set terminal screen length. Default length is 24 lines. This value is used by the ASM to determine when to do paging or "moreing" of the output. A screen length of zero causes the ASM to never do paging.

location *text*
no location Describes the terminal's location and/or status. This text appears in the systat command. It is suggested that every ASM line have a location description in the configuration file for ease of locating lines.

[no] login Indicates that if the line has a password, a user must give that password before getting an ASM EXEC. For this to be effective you must specify a password for the line.

login-string *host c banner c*
no login-string *host*

> Defines a string of characters to be sent to the specified host upon a successful connection attempt. The command syntax is similar to the **banner** configuration command. Note that padding in the form of spaces may be required and that the string itself should be no longer than 100 characters.

[no] modem callin|callout

> Indicates that modem control signals should be used on this terminal line. **modem callin** is used for incoming connections, such as from modems on phone lines. **modem callout** is used for outgoing connections, such as from rotary lines.

[no] notify Corresponds to the **set notify** command at the user command level. A terminal with multiple connections with **notify** set will alert a user of pending output on inactive connections.

parity none|even|odd|space|mark

> Define the handling of the parity bit. The default is to not have any parity handling, that is, no parity bit is generated and none is checked.

password *password*
no password

> Sets the password for the line. If this is specified for the console line (line zero), that will be the password for the privileged command mode.

[no] private

> Ensures that user setttable configuration commands such as **set notify** or **set download** will remain in effect between ASM terminal sessions. This behavior is desirable for terminals located in private offices.

rotary *group*
no rotary   Specify that this line is in rotary group number *group* (decimal). This is for use in conjunction with TCP port $3000_{10}+group$ and $5000_{10}+group$. See section 2.3 for more details. This attribute may not be specified for the console.

session-timeout *interval*
no session-timeout

> Define the interval (in minutes) that a connection will wait for typein before closing the connection and returning the terminal to an idle state. An interval of zero means no session timeout is in effect; this is the default value.

speed *baud*
txspeed *baud*
rxspeed *baud*

> Set the speed for the line. **txspeed** and **rxspeed** set the transmit (to terminal) and receive (from terminal) speeds independently. **speed** sets both transmit and receive speeds. Legal baud rates include 150, 300, 1200, 2400, 4800, 9600, and 19200 baud. The default speed is 9600 baud.

start-character *value*

> When software flowcontrol is in effect, this is the character that signals the start of data transmission. *Value* is the decimal representation of the desired ASCII character. CTRL/Q is the default start character.

stop-character *value*

> When software flowcontrol is in effect, this is the character that signals the cessation of data transmission. *Value* is the decimal representation of the desired ASCII character. CTRL/S is the default stop character.

stopbits 1 | 2

> Adjust the number of stop bits transmitted. By default the ASM sends two stop bits.

terminal-type *text*
no terminal-type

> Records the type of the terminal connected to the line. This will be used to inform the host of the terminal type. Not yet implemented.

vacant-message *c banner c*
no vacant-message

> Defines a message to be printed on the screen of a vacant terminal. The command syntax is the same as the **banner** configuration command.

5.3. Network Configuration Commands

The following commands set up the local network configuration and hence should be applicable to all AGS and ASM hosts on the local network. Individual hosts may override these configuration options with their host configuration files or by manual reconfiguration. Some commands apply to both the AGS and ASM hardware configurations, others are specific to the AGS Gateway Server. The addresses given as arguments to these commands are decimal Internet addresses of the form *nn.nn.nn.nn*.

domain-name *name*
no domain-name

> Specifies the domain in which unqualified host names are assumed to be. An unqualified name is a name that doesn't have a dotted domain name such as ''.CISCO.COM'' appended to it.

domain-server *server-address1 server-address2*

> Specifies the IP addresses of up to six domain servers to use for name and address resolution. The default is to broadcast on the connected network(s) that support hardware broadcasts.

egp-neighbor *address autonomous-system* [**primary**]
no egp-neighbor *address*

> (AGS ARPA gateway only) Define an EGP neighbor with which to exchange reachability information. *address* is the IP address of the neighbor and *autonomous-system* is the number of the autonymous system the AGS is representing. The optional keyword **primary** adds the EGP neighbor to the list of primary routers. The primary routers are a collection of usually core gateways that provide most of the routing information to the AGS. Several primary routers may be acquired simultaneously, up to a maximum number specified by **primary-neighbors** command. Excess primaries are kept in reserve should some of the acquired primaries become inaccessible. Non-primary neighbors are always acquired and are assumed to provide reachability information supplementing the primary neighbors.

[no] lookup *service*

> This command tailors the ASM or AGS's use of network based information servers. Services include:

> > ● **config** -- TFTP auto-loading of configuration files, default on.

> > ● **domain** -- use domain based name and address translation, default on.

> > ● **ipname** -- use IEN-116 name translation, default off.

> > ● **time** -- get date and time from the network, default on.

primary-neighbors *count*

>   (AGS ARPA gateway only) Specifies the maximum number of primary EGP neighbors that the AGS may acquire simultaneously. See the **egp-neighbors** command for further details.

route *destination-address gateway-address* [**default**]
no route *destination-address*

>   Define a static network routing entry. The destination and gateway addresses are usually two addresses of the same gateway host. The **default** keyword is optional and selects a route to be used when all other routing possibilities are inappropriate. An AGS will ignore any static route that specifies an interface address of that very same AGS. Note as well that EGP speaking gateways should *never* use the **default** keyword.

routing-protocol *network-address method data*

>   Defines the routing update protocol on a particular network. *network-address* is the IP address of a network. *method* is a keyword that specifies the update protocol. At present, *method* may be **none**, **gwinfo**, **igrp**, or **egp**. The *data* field is currently used only by EGP and is the autonomous system number of the AGS. **Note well:** *An AGS will not route datagrams unless there is a routing protocol defined for each of its connected major IP networks.*

stranded-subnet *subnet-address server-address*
no stranded-subnet *subnet-address*

>   (AGS only) Identifies *subnet-address* as a subnet that is stranded, *i.e.* that doesn't have a reasonable set of server hosts. The host portion of the *subnet-address* is ignored. *Server-address* is the address of a host or subnet providing services to hosts on *subnet-address*. If *server-address* is a subnet broadcast address (host portion is all ones), service requests will be broadcast to all hosts on that subnet. If none of the ASM's interfaces are connected to *subnet-address*, the command is ignored. This allows all stranded subnets to be listed in one "network-confg" file.

5.4. Access Lists -- Restricting Network Access

The ASM allows a very general specification of access restrictions on a line-by-line basis. Classes of access are first defined with access lists, then an access class is assigned to each line.

An access list is a sequential collection of permit and deny conditions that are applied to an IP address. The conditions are tested, one by one. The first match determines whether the address is accepted or rejected. If none of the conditions in the list match, the address is rejected.

Each condition is specified with an **access-list** configuration command:

```
access-list list permit|deny address mask
```

Access lists are numbered from one to 900[3]. The address being tested is compared against *address*, with any bits which are set in *mask* ignored. If **permit** is specified, a match causes the address to be accepted. If **deny** is specified, a match causes the address to be rejected. There may be up to 20 permit/deny conditions per access list.

In the following examples, net 36 is a Class A network whose second octet specifies a subnet. The last 16 bits of a net 36 address specify a host.

The following access list would only accept addresses on three subnets (decimal 48, 21, and 27).

```
access-list 1 permit 36.48.0.0  0.0.255.255
access-list 1 permit 36.21.0.0  0.0.255.255
access-list 1 permit 36.27.0.0  0.0.255.255
```

The following access list would accept one address on subnet 48 and reject all others on that subnet. Addresses on all other net 36 subnets are accepted.

```
access-list 2 permit 36.48.0.3  0.0.0.0         ! allow one host
access-list 2 deny   36.48.0.0  0.0.255.255     ! block subnet 48
access-list 2 permit 36.0.0.0   0.255.255.255   ! all of net 36
```

In this example, the ordering of permit/deny operations is important.

The **access-class** configuration command is used to restrict connections on a particular line to the IP addresses accepted by an access list. Incoming and outgoing connections are checked separately.

```
access-class list in | out
```

In addition to the definable lists one through 900, access list zero is special -- it accepts any address. This is the default access list.

Access lists may be examined with the **show lines** and **show access-lists** commands.

5.5. Sample Configuration Files

Figure 5-1 shows an example of a typical ASM host configuration file. This ASM has some dial-in lines which are to be restricted so that they can't get to certain subnets. The virtual terminals are restricted so that they can't connect to *any* address.

Figure 5-2 shows an example of a net configuration file for the Stanford University Network. The Golden Gateway (36.8.0.1) is the primary gateway between the SU-Net and the Arpanet (net 10). It is also used to route packets to networks for which there isn't a known route.

Figure 5-3 shows an example of a host configuration file for the AGS ARPA gateway linking the ARPANET to two subnets of the Stanford University Network.

---

[3]Lists 901 through 999 are reserved for internal functions.

```
! ASM-wide settings.
line 0 60
private                              ! All private lines.
!
! Line-specific settings.
line 0
location ASM Console
line 1
location Someone's Office
line 2
        :
        :
line 20
location unused
!
! Modem Lines
access-list 1 deny   36.48.0.0  0.0.255.255      ! LOTS-Net
access-list 1 deny   36.21.0.0  0.0.255.255      ! LOTS-10MB-Net
access-list 1 permit 0.0.0.0    255.255.255.255
line 21 32
modem callin
autobaud low
no private
access-class 1 out
!   Location information for modems.
line 21
location dialups #1
        :
        :
line 32
location dialups #10
!
!   Other lines.
line 33
location Public Terminal
no private
speed 4800
line 34
        :
        :
line 60
location Another Office

! Restrict the virtual terminals
access-list 2 deny 0.0.0.0   255.255.255.255
line 61 65
access-class 2 out
!
end
```

Figure 5-1:   Typical ASM Configuration File

```
! This is the default network configuration file.  Stored as:
!
!       /usr/sun/bootfile/network-confg
!       PS:<SUN-BOOTFILES>NETWORK-CONFG.BOOT
!
! Define routing protocol for SU-Net.
routing-protocol 36.0.0.0  gwinfo
!
! Define path to Arpanet (10), make it the gateway of last resort
! Define path to DECWRL (128.45) via a non-AGS gateway
route 10.0.0.0   36.8.0.1  default
route 128.45.0.0  36.22.0.10
!
! Define default domain name
domain-name STANFORD.EDU
!
! Define domain servers (broadcast, ARGUS, SRI-NIC.ARPA)
domain-server 255.255.255.255  36.53.0.10  10.0.0.51
!
! Use domain service to lookup names. Use net servers to get time.
! Don't use IEN-116 name lookup.
lookup domain
lookup time
no lookup ipname
!
! List some stranded subnets.
stranded-subnet 36.26.0.0 36.48.0.0        !CroMem-Net  LOTS-Net
stranded-subnet 36.19.0.0 36.8.0.0         !GSB-Net     MJH-10MB-Net
!
end
```

Figure 5-2:   Typical Network Configuration File

```
! Configuration file for the Stanford-Gateway
! Last updated 20-June-1986
!
hostname Stanford-Gateway
!
interface sun  0 36.36.0.5   255.255.0.0  1500  ! SU, CSD-3MB-Net
interface 3com 0 36.8.0.1    255.255.0.0  1500  ! SU, MJH-10MB-Net
interface arpa 0 10.1.0.11   255.0.0.0    1008  ! Arpanet
!
routing-protocol 10.0.0.0 egp 32
routing-protocol 36.0.0.0 gwinfo
!
primary-neighbors  2                       ! Two primaries at once
egp-neighbor 10.3.0.27   32 primary        ! ISI-Gateway
egp-neighbor 10.2.0.37   32 primary        ! Purdue-Gateway
egp-neighbor 10.7.0.63   32 primary        ! BBN-Net2-Gateway
egp-neighbor 10.0.0.94   32 primary        ! WISC-Gateway
!
route 128.88.0.0 10.4.0.5                  ! HP Labs via CSNET-RELAY
!
end
```

Figure 5-3:   AGS Host Configuration File for Stanford ARPANET Gateway

6. ASM/AGS Protocol Support

The following descriptions highlight the ASM/AGS protocol handling. These descriptions are not intended to be complete, e.g., details such as never sending ICMP messages in response to ICMP messages are omitted.

6.1. IP -- Internet Protocol

On reception of an IP datagram, the header is verified, the checksum computed, and the time to live field decremented. Datagrams found wanting are noted and dropped without further processing. The datagram's destination address is then examined. If it aimed at one of the local host's addresses, the datagram is enqueued for the appropriate protocol process after any necessary fragment reassembly is completed. Broadcasts are always enqueued for the local host.

If gateway processing is enabled, datagrams destined for other hosts are routed. If no route exists and the IP originator is on the same cable as the interface, an ICMP host unreachable message is sent back. If the route involves sending the datagram out the same interface as it came in on, an ICMP host redirect message is sent. If the datagram size is larger than the MTU of the output interface, the datagram is fragmented.

The IP type of service field is ignored, as are all IP options.

The following IP based protocols are supported: ICMP, TCP, UDP, and EGP.

6.2. ICMP -- Internet Control Message Protocol

In addition to sending ICMP host unreachable and host redirect messages as mentioned previously, the ASM/AGS supports several other ICMP functions.

The privileged **ping** command can be used to send ICMP Echo messages to check host reachability and network connectivity. Upon receipt of an Echo message, the ASM/AGS will respond with an ICMP Echo Reply.

During the initialization process, the ASM/AGS will attempt to use the ICMP Mask Request message to ascertain the state of subnetting on the local networks. If gateway processing is enabled, the AGS will respond to ICMP Mask Requests with the appropriate Mask Reply messages.

The ASM listens to ICMP destination unreachable messages when attempting to create TCP connections to other hosts. Such messages are ignored for active connections in case the condition proves transient.

ICMP redirects are ignored by the AGS. Since the AGS is supposed to be communicating routing information with other gateways, it is presumed to have better information. The ASM, however, does use the gateway specified by the redirect message.

6.3. UDP -- User Datagram Protocol

The following UDP based protocols are supported.

- Date and time lookup, as per RFC 868. The time is used, among other things, to record system boot time.

- Domain name lookup, as per RFC 882 and 883. Name string to address and address to name string functions are supported.

- Trivial File Transfer Protocol (TFTP), as per RFC783. Currently only TFTP read requests are supported. TFTP is used to load configuration files over the network.

- Boot Protocol (BOOTP), as per RFC951. Used to determine interface addresses when there is no valid non-volatile configuration memory.

- IEN-116 Name Translation. A name string to address translation protocol rendered obsolete by the domain server protocol.

- Interior Gateway Routing Protocol (IGRP). No RFC. A protocol developed by cisco Systems to support the exchange of routing information among the interior gateways of a possibly subnetted network.

6.4. TCP -- Transmission Control Protocol

Telnet virtual terminals as specified in RFC764 are the major TCP application supported by the ASM. Of the possible Telnet options, currently only echo, binary mode, suppress go-ahead are supported. The Telnet break, no-op, and go-ahead commands are also supported.

Raw TCP byte streams are available through the serverport facility described in section 2.3.

6.5. EGP -- Exterior Gateway Protocol

The Exterior Gateway Protocol as specified in RFC904 is supported in the AGS series A gateways. Refer to the discussion in section 3.2 for details.

6.6. Non-IP Protocols

The Address Resolution Protocol (ARP) is used to resolve IP protocol addresses into 10MB Ethernet hardware addresses. Reverse ARP is used to determine interface addresses when there is no non-volatile configuration memory. ARP and RARP are specified in RFC's 826 and 903.

PUP (PARC Universal Protocol), an obsolete Xerox internet protocol, is minimally supported in some versions of the AGS software. PUP gateway functions including GWInfo, miscellaneous service forwarding, Echo, and name/address lookup functions are present in those versions. The Xerox address resolution protocol for 10MB Ethernets is also supported.

Appendix A
Terminal Status and Capability Flags

This appendix lists the defined status and capability bit flags for terminal lines. The show lines command refers to these bit flags.

```
/*
 * Terminal status bits
 */
#define TXENABLE      0x1        /* enable UART transmitter */
#define FIRSTESC      0x2        /* first char in escape seq rcvd */
#define ESCAPED       0x4        /* full escape sequence typed */
#define PSIENA        0x8        /* pseudo interrupts enabled */
#define RINGIN        0x10       /* Ring Indicate transition rcvd */
#define IDLE          0x20       /* the modem is idle */
#define READY         0x40       /* the modem is ready */
#define HANGUP        0x80       /* user hung up modem */
#define MODEM         0x100      /* line is a modem */
#define CARDROP       0x200      /* carrier dropped or vty died */
#define HASPROC       0x400      /* line has a process */
#define LASTWASCR     0x800      /* last character was a RETURN */
#define HOLDING       0x1000     /* user typed hold character */
#define WANTXON       0x2000     /* XOFF recvd, wait for XON */
#define SENTXOFF      0x4000     /* we sent XOFF */
#define AUTOBAUDING   0x8000     /* line doing autobaud detect */
#define ROTARY        0x10000    /* member of a hunting group */
#define VTY           0x20000    /* line is a pseudo terminal */
#define PRINTER       0x40000    /* line is a parallel printer */
#define CTSASSERT     0x80000    /* CTS must be high on this line */
#define NOBANNER      0x100000   /* never print a logout banner */
#define IDLETIMEOUT   0x200000   /* session is very idle */
#define LASTWASBREAK  0x400000   /* last "character" was a BREAK */


/*
 * Terminal capabilities word
 */
#define ENABLED       0x1        /* user knows privileged password */
#define WANTSLOGIN    0x2        /* must supply password to use line */
#define NOTIFY        0x4        /* notify on new data arrival */
#define NOEXEC        0x8        /* never create an EXEC */
#define PRIVATE       0x10       /* private terminal line */
#define DOWNLOAD      0x20       /* optimize for downloading files */
#define SFLOWIN       0x40       /* software flowcontrol in */
#define SFLOWOUT      0x80       /* software flowcontrol out */
#define AUTOBAUDLOW   0x100      /* autobaud detect, 300 - 2400 */
#define AUTOBAUDHIGH  0x200      /* autobaud detect, 2400 - 19200 */
```

```
#define HFLOWIN      0x400  /* hardware flowcontrol in */
#define HFLOWOUT     0x800  /* hardware flowcontrol out */
#define MODEMIN      0x1000 /* modem control in - passive */
#define MODEMOUT     0x2000 /* modem control out - active */
```

Appendix B
Processor Jumper Settings

This appendix defines the jumper settings of the cisco Systems CS10 processor board. When viewing the processor card from the front, component side up, the processor jumper area is the right most 16 pairs of pins on the left connector area. Bit zero is the right most jumper.

Bit Field	Description
13 - 15	Reserved.
11 - 12	Console terminal baud rate.

        0 - 9600 baud

        1 - 4800 baud

        2 - 1200 baud

        3 - 300 baud

10	Enable HDLC support on console port B.
9	Restart on error.
8	Ignore BREAK key on console terminal.
0 - 7	Boot action code.

        0 - manual boot mode, type ''h'' for help.

        1 - boot default ROM software.

The factory default is to boot the default ROM software, to restart on error, to ignore the BREAK key on the console, and to run the console terminal at 9600 baud, that is, jumpers 0, 8 and 9 are inserted.